SPECTRUM OF THYROID DISORDERS, IODINE STATUS AND DIABETES MELLITUS IN ADULT KERALA POPULATION –
A COMMUNITY STUDY

THESIS SYNOPSIS

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CHAPTER 1

ABSTRACT

Diabetes and thyroid disorders are the two commonly encountered endocrine diseases in adult population in all parts of the world. However, there is insufficient epidemiological data on these disorders from India especially on thyroid disorders. Though there have been few national and regional cross sectional community studies on diabetes, the population of Kerala having very high health indices were not adequately studied. Regarding thyroid disorders there are no epidemiological data on adults from India other than the study on iodine deficient population of Gujarat done many years ago.

The main objective of this work was to generate valuable epidemiological data regarding the prevalence of thyroid disorders and diabetes mellitus in an adult south Indian population from Kerala. Another aim was to evaluate the iodine status and thyroid autoimmunity and their contribution to thyroid dysfunction and goiter in this population.

First phase of the study was conducted as a cross sectional community survey in different parts of Ernakulam District. The study was approved by the institutional ethics committee. In order to get a representative sample, houses were selected from the study area by WHO cluster sampling method and a house-to-house survey was conducted. Residents above the age of 18 years from selected houses were interviewed by trained field workers using a validated questionnaire and details of socioeconomic status, diet, lifestyle pattern, history of relevant illnesses and drug history from each individual were collected. After the initial survey, anthropometric measurements, physical examination including BP and goiter evaluation as well as biochemical evaluation of blood and urine were conducted on the surveyed subjects at their locality. Blood tests such as blood sugar, lipid profile, thyroid function tests,
anti TPO and anti TG antibody were done in AIMS hospital laboratory. The urine iodine excretion estimation was done in AIIMS IDD laboratory, New Delhi. In this study 3064 subjects were surveyed and among them 986 subjects were subjected to further evaluation.

During the second phase of the research, another cross sectional community survey was carried out regarding thyroid problems in females who were middle age and above in a different locality of Ernakulam district. Houses were selected by WHO suggested cluster sampling method and one female above 35year was selected randomly from each house for the study. In addition to the questionnaire survey, physical examination including BP measurement and goiter assessment, blood tests, and urine tests were done. All subjects underwent ultrasound scan of the thyroid for assessing thyroid volume and nodularity using a portable ultrasound machine. Among the 540 females surveyed, 508 participated in the further check up. All data were entered into SPSS software and analyzed using appropriate statistical methods.

Results of these two community survey revealed a higher prevalence of diabetes and thyroid disorders in this population than previously hypothesized and majority of these were newly detected cases. After nearly two decades of salt iodization, iodine status of these populations was found to be sufficient, probably due to the consumption of iodized salt and seafood, especially fish. However, prevalence of goiter was higher than expected for an iodine sufficient adult population suggesting possible presence of unidentified goitrogens. Thyroid dysfunction was much higher than previously hypothesized and the commonest disorder was subclinical hypothyroidism followed by overt hypothyroidism. However, only about 40-60% of the goiters and thyroid dysfunction had autoimmune etiology. This high prevalence of thyroid dysfunction especially subclinical hypothyroidism among adults without an increase in autoimmunity might be the effect of transition from iodine deficiency to sufficiency even though the lack of pre iodization data makes it difficult to put forward a firm conclusion. Nevertheless, the role of environmental chemicals contributing to this high prevalence of thyroid dysfunction in this population is
another possible explanation, which needs further exploration. As part of the study
normal distribution of thyroid volume of the females above middle age was identified
and it showed negative correlation with age and positive correlation with body
weight. Prevalence of nodular changes in this population by ultrasound was also
described for the first time in an adult population of India. All these observations
highlight the importance of monitoring thyroid problems periodically with the
perspective of iodine status and the need for further larger studies in this direction.
CHAPTER 2

SPECTRUM OF THYROID DISORDERS AND ITS RELATIONSHIP WITH THYROID AUTOIMMUNITY AND IODINE STATUS OF ADULT POPULATION IN CENTRAL KERALA

BACKGROUND

Since the implementation of universal salt iodization in 1986, results of many recent studies done in various parts of India have shown that iodine status of the population has become adequate, though pockets of iodine deficiency still exist. Hence, India is said to be in the transition phase from iodine deficiency to iodine sufficiency, and this is expected to change the spectrum of thyroid disorder of the population. The thyroid status and autoimmune status of adult Indian population in the post iodization phase is largely unknown, as most of the nationwide surveys were conducted among school children.

OBJECTIVES

The purpose of the study was to assess the prevalence of various thyroid disorders and to evaluate iodine status and thyroid autoimmunity in adult population.

MATERIALS AND METHODS

This survey was conducted in south central Kerala in four randomly selected areas of the Ernakulam district in order to obtain a representative sample. The total population in the selected area is estimated as 350,000. For diabetes prevalence, the sample size was estimated at 750 adults based on an estimated 12% prevalence of DM in the community, an α error (type 1 error) of 0.05 and allowable error on the
estimate of 20%. The prevalence of other endocrine disorders in the Indian adult population is not known but assuming similar figures as published, a prevalence of 3-4% would require a sample size of 3000. The study was approved by institutional ethics committee.

From the four selected areas, households were selected as per the cluster-sampling scheme suggested by W.H.O. Trained fieldworkers conducted a 15-minute survey using validated questionnaire and collected details of demographic and socio-economic status (SES), medical history, lifestyle details and dietary pattern from all adult residents above the age of 18 years, from selected houses.

The surveyed population was invited to participate in the second phase of the study, which included physical evaluation and biochemical investigations which was conducted at their locality. In the health check up, in addition to the anthropometric measurements and physical examination, goiter evaluation was done by physician and was graded as per the definition of WHO/UNICEF/ICUDD (1992). Blood sample was collected for the evaluation of serum Thyroid Stimulating Hormone (TSH), free Thyroxine (FT4) and free Triiodothyronine (FT3), anti Thyroid Peroxidase Antibody (Anti TPO) and anti Thyroglobulin Antibody (Anti TG) which were estimated by Electro Chemiluminescence Immuno-Assay (ECLIA) using Elecsys 2010 Roche. Urine sample was collected and iodine was estimated by simple micro plate method using ammonium persulphite digestion and Sandell Kolthoff’s reaction at AIIMS IDD Lab, New Delhi.

The software SPSS for Windows (Version 11) was used for the data management and statistical analysis ($X^2$ test or Fisher’s exact test and Stepwise logistic regression analysis where ever applicable).

RESULTS

The final study sample included 931 houses and 3069 adults. The initial survey of 3069 subjects showed that 2.2% (67) of the population had already-diagnosed thyroid disorders and majority of these were females (M-7, F-60). Twenty four subjects had hypothyroidism and 12 had history of hyperthyroidism. Among the population 98.4% were using iodized salt.
Among the surveyed population 986 subjects (M -389   F -587) participated in the second phase of the study. Mean age was 44.8±14.9 yrs. Age and gender distribution of the study subjects are shown in Fig.1. Among them 24 reported that they had hypothyroidism, 7 had hyperthyroidism whereas, 8 subjects were not sure of type of their thyroid problem. Eight subjects had undergone thyroid surgery and a case of diagnosed papillary carcinoma undergoing treatment was also noted.

![Graph showing age and gender distribution of study subjects](image)

**Fig.1 Age and gender distribution of the study subjects (986)**

**IODINE STATUS**

Urine iodine estimations were done in 954 subjects. Results showed that median Urine Iodine Excretion (UIE) was 211.4mcg/l (mean 220.3 ± 99.5mcg/L) suggesting iodine sufficiency. Iodine deficiency, UIE < 100 mcg/l was seen only in 15.1% of the subjects while 30.1% had iodine excess i.e. UIE rate of > 300 mcg/l. There was no value over 500 mcg/l.

**GOITER**

The total prevalence of goiter was 12.2% (Grade 1- 8.7%, Grade 2 - 3.5%) and was significantly (p<0.001) higher in females than in males (16.1% vs. 6.0%). Prevalence of goiter decreased significantly (p=0.02) with increasing age among females. Though males >60 years had more goiter than young subjects, this difference was not statistically significant (p=0.23). Goiter was more common among iodine deficient subjects (17.1%) compared to those with normal or high UIE (11.5%). Neither iodine
deficiency nor autoimmunity could be detected in 42% of goitrous people. Regarding thyroid function status of goitrous subjects, 18.4% had hypothyroidism, 13.2% had subclinical hypothyroidism and 4.3% had hyperthyroidism and the rest (64.1%) were euthyroid.

**THYROID FUNCTION STATUS**

Subjects taking Amiodarone, Lithium and subjects with pregnancy were excluded from this analysis. Biochemical evaluation of the thyroid status among 971 subjects showed 19.6% had thyroid function abnormalities; subclinical hypothyroidism being the most common disorder (Table.1). Thyroid dysfunction was found significantly (p<0.001) more among females than males. Thirty-four subjects had thyroid function test, which were not classifiable without repeat testing.

Table.1 Pattern of thyroid dysfunction among the study population (971)

<table>
<thead>
<tr>
<th>Thyroid Status</th>
<th>Males (383)</th>
<th>Females (588)</th>
<th>Total (971)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal TFT</td>
<td>332 (86.7%)</td>
<td>449 (76.4%)</td>
<td>781 (80.4%)</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>3 (0.9%)</td>
<td>35 (5.9%)</td>
<td>38 (3.9%)</td>
</tr>
<tr>
<td>Hyperthyroidism</td>
<td>5 (1.3%)</td>
<td>8 (1.4%)</td>
<td>13 (1.3%)</td>
</tr>
<tr>
<td>Sub. Hypothyroidism</td>
<td>24 (6%)</td>
<td>67 (11.5%)</td>
<td>91 (9.4%)</td>
</tr>
<tr>
<td>Sub. Hyperthyroidism</td>
<td>2 (0.8%)</td>
<td>12 (1.9%)</td>
<td>14 (1.4%)</td>
</tr>
<tr>
<td>Abnormal TFT*</td>
<td>17 (4.7%)</td>
<td>17 (2.1%)</td>
<td>34 (3.4%)</td>
</tr>
<tr>
<td>Total abnormalities</td>
<td>51 (13.3%)</td>
<td>139 (23.6%)</td>
<td>190 (19.6%)</td>
</tr>
</tbody>
</table>

*Thyroid function test which was not classifiable into any of these categories

The results showed that odds of getting thyroid dysfunction in females is 1.67 times higher than in males (p=0.015). Thyroid dysfunctions were more common in older
subjects (Fig. 2). Subjects with goiter were more likely to have thyroid dysfunction compared to normal subjects (OR= 1.79, p=0.002). Positive anti-TPO was found to be stronger predictor of thyroid disease (OR=6.82, p<0.001) than positive anti-TG antibody(OR=1.98, p=0.00).

Fig. 2 Relationship between thyroid dysfunction and age

THYROID ANTIBODIES

Among the study population, anti TPO was positive in 16.7% and anti TG was positive in 12.1% of the subjects. Both antibodies were positive in 57 patients (5.8%). Females had significantly higher prevalence of both antibodies than males [anti TPO 19.8% vs 11.8% (p<0.001) and anti TG 15.1% vs 6.1% (p<0.00)]. In the population with normal thyroid function, only 9.5% had positive anti TPO and 8.5% were anti TG positive whereas among those with thyroid functional abnormalities 46.3% had positive anti TPO and 26.8% had positive anti TG.

CONCLUSION

To summarize, this study clearly showed that undetected thyroid disorders are very high in this iodine sufficient community necessitating development of appropriate
screening strategies to detect and treat these conditions considering the magnitude of health problems it can cause to the population. Female gender and presence of goiter are more predictive of thyroid dysfunction and this is similar to the results of other studies. Among subjects with thyroid dysfunction, autoimmunity was the commonest etiology of these disorders. Positive anti TPO antibody is found to be correlating strongly with thyroid dysfunction than anti TG antibody. This suggests that anti TPO alone is a much better predictor of thyroid dysfunction, which can be used reliably in clinical practice. The high prevalence of subclinical hypothyroidism should be viewed with due importance in this population considering its potential to cause dyslipidemia and cardiovascular disease. This also suggests the need for larger studies with adult population from across the nation to get a clearer profile of thyroid disorders in India. Finally, this highlights the fact that in addition to iodine deficiency diseases, other thyroid disorders too need to be given equal importance in adult populations, especially in regions, which are moving from iodine deficiency to iodine sufficiency.
CHAPTER 3

DIABETES MELLITUS, OBESITY, HYPERTENSION AND DYSLIPIDEMIA IN ADULT CENTRAL KERALA POPULATION

BACKGROUND

Over the last two decades, urbanization, westernization as well as general improvement in economic status and living standards have lead to substantial changes in diet and lifestyle of population of Kerala - southern state of India which now shows similar demographic features of western countries. These changes have been associated with a marked increase in the prevalence of non-communicable lifestyle related diseases such as diabetes, hypertension and coronary artery disease among the Kerala population. The National Urban Diabetes Survey conducted in 2001 was the only national study that had included a small sample population from Kerala which reported a diabetes prevalence of 12.1%. There have been only two previous studies looking at the prevalence of diabetes in Kerala and both were in south Kerala. These studies showed that 23.4% of diabetes cases are undetected in this population.

OBJECTIVE

The study was conducted as part of a multipurpose community based survey to evaluate the prevalence of diabetes mellitus (DM) and to identify the risk factors associated with type 2 diabetes.

MATERIALS AND METHODS

This survey was conducted in south central Kerala in four randomly selected areas of the Ernakulam District in order to obtain a representative sample. Detailed methodology is given in Chapter 2. During the health check up anthropometrical measurements such as height, weight, skin fold thickness, waist circumference and
hip circumference were measured. A physician verified medical history and performed physical examinations including blood pressure (BP) and examination for Acanthosis Nigricans. A 75 gram glucose tolerance test was done to all subjects except those with known diabetes. Fasting and 2-hour capillary blood glucose was assessed by a calibrated glucometer by the glucose oxidase method. Diabetes was defined by WHO criteria using capillary glucose measurements.
The software SPSS for Windows (Version 11) was used for data management and statistical analysis (X^2 test or Fisher’s exact test and Stepwise logistic regression analysis where ever applicable).

RESULTS
The prevalence of known diabetes was 9.0% (276/3069), Males- 8.7% (129/1479) and Females-9.2% (147/1590). The age and anthropometric variables of total of the 986 subjects (M 389, F 597) who participated in the screening are given in Table. 1.

Table.1 Distribution of study variables among screened population (986)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male (Mean±SD)</th>
<th>Female (Mean±SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Yrs)</td>
<td>45.3 ± 15.4</td>
<td>44.4 ± 14.7</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.5 ± 7.3</td>
<td>151.7± 6.7</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>61.69±12.6</td>
<td>51.9 ± 11</td>
</tr>
<tr>
<td>BMI (Kg/m^2)</td>
<td>22.4 ± 3.8</td>
<td>23.4 ± 4.3</td>
</tr>
<tr>
<td>Waist Circumference (cm)</td>
<td>81.6 ± 11.6</td>
<td>76.8±10.7</td>
</tr>
<tr>
<td>Hip Circumference (cm)</td>
<td>89.7 ± 10.7</td>
<td>90.3 ± 9.6</td>
</tr>
<tr>
<td>Waist Hip Ratio</td>
<td>0.9 ± 0.06</td>
<td>0.85±0.07</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>125.6±17.3</td>
<td>124.6±18.3</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>78.8 ± 9.1</td>
<td>77.7 ± 8.6</td>
</tr>
</tbody>
</table>

There were 174 subjects with diagnosed DM. Based on OGGT, a further 85 new cases of DM (prevalence of newly diagnosed DM 10.5% ie (85/986-174) were
identified giving a total prevalence of 19.5%. Newly detected diabetes was more common among males (11%) compared to females (8.4%) but this difference was not statistically significant. The prevalence of impaired glucose tolerance (IGT) was 4.1% (34/812) and impaired fasting glucose (IFG) was 7.1% (59/812). Prevalence of IGT was similar in both genders (Male 4.3%, Female 4.09%).

The prevalence of diabetes showed a steady increase with age (Fig.1). The prevalence of IGT also showed similar age trend especially in females. The prevalence of DM showed a progressive increase with increase in body mass index (BMI) especially above 25kg/m² (Fig.2). Acanthosis nigricans was present in 16.5% (152/963) of the population and was more common in females (20%) than males (11.2%).

![Fig.1: The prevalence of DM by age and gender](image)

Multivariate logistic regression analysis showed that increasing age, positive family history of DM, increasing BMI, male gender, high STR and presence of AN had significant positive association with diabetes. Age had the highest relative risk followed by positive family history of diabetes and BMI.
PREVALENCE OF COMORBIDITIES
In this study population 20.2% (202 subjects) had history of hypertension (M 22.4% F 19.2%). After evaluation 110 new subjects were found to have hypertension making a total prevalence of hypertension in this population as 32%. Prevalence of hypertension was similar in males (32.5%) and females (31.8%) (p NS). Obesity (BMI >25) was present in 31.7% (309) of the study subjects and was significantly higher in females (35.8%) than males (25.3%) (p <0.001). Among these subjects, 32% (311 subjects) had total cholesterol >230mg/dl and 23.2% (226 subjects) had had triglyceride >150mg/dl. Prevalence of AN and obesity decreased with increasing age where as diabetes, hypertension, high cholesterol and high triglyceride showed steady increase with increasing age (Fig.3).

Fig. 2 Prevalence of DM, IGT and IFG among different BMI Categories
CONCLUSION

The results indicated a much higher prevalence of DM compared to earlier studies done based on old WHO criteria for diagnosing diabetes (fasting plasma glucose of 140mg/dl), whereas this study used the new criteria (FPG 126mg/dl equivalent to capillary value of 110mg/dl). The finding of high prevalence of newly detected DM and IGT in this population of Kerala with the highest standards of health care and literacy level compared to other states of India emphasizes the need for routine screening of high-risk groups for early detection of the disease. Increasing age, positive family history of DM, increasing BMI, male gender, high STR and presence of AN had significant positive association with diabetes. Comorbidities like hypertension, obesity and dyslipidemia were also found to be common in this population.
CHAPTER 4

PREVALENCE OF GOITER, THYROID DYSFUNCTION AND THYROID AUTOIMMUNITY IN DIABETIC SUBJECTS IN A CENTRAL KERALA POPULATION

BACKGROUND

Diabetic patients, who are already having higher risk of cardiovascular disease have been shown to have a higher prevalence (13.4%) of thyroid dysfunction as compared to general population in a study conducted at a diabetic outpatient clinic in Europe. Similarly the prevalence of undiagnosed thyroid disease in diabetic patients receiving community diabetes care was also shown to be higher than general population (5.5%). But studies in India were all done in type 1 diabetes and the prevalence of thyroid problems in type 2 diabetes is largely unknown.

OBJECTIVES

The objective of this study was to assess the prevalence of goiter, thyroid dysfunction and antibody positivity in diabetic subjects and to compare it with nondiabetic subjects in the community.

MATERIALS AND METHODS

Sample selection and survey were done as described in Chapter 1. In addition to the anthropometric measurements and physical examination, goiter evaluation was done by a physician and was graded as per the definition provided by the WHO/UNICEF/ICUDD (1992). Blood sample was collected for the evaluation of
serum Thyroid Stimulating Hormone (TSH), free Thyroxine (FT4), free Triiodothyronine (FT3), anti Thyroid Peroxidase Antibody (Anti TPO) and anti Thyroglobulin Antibody (Anti TG). Data were analyzed using SPSS software version-11.0.

RESULTS

From the total population of 986, diabetic subjects (258) were compared with non-diabetic subjects (728) regarding prevalence of goiter, thyroid dysfunction and presence of autoantibody. The prevalence of goiter was similar in both groups (P=0.26). Thyroid dysfunction (P=0.17 and antibody positivity (P=0.19) were higher in nondiabetic subjects but this difference was not statistically significant (Fig.1). Prevalence of different types of thyroid dysfunction was also similar in diabetic and nondiabetic subjects (Fig.2).

![Bar chart](image)

Fig. 1 Distribution of various thyroid disorders in diabetic and nondiabetic subjects (in percentage).

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Fig. 2 Prevalence of various thyroid dysfunctions in categories of glycemic status in percentage.

**Conclusion**

These results showed that thyroid problems are similar in type 2 diabetic and nondiabetic subjects in this population. However goiter was higher in diabetic males and lower in diabetic females compared to their nondiabetic counter parts. Commonest thyroid problem was subclinical hypothyroidism followed by overt hypothyroidism in both groups. Large number patients had undetected thyroid dysfunction and would benefit from screening for undetected thyroid dysfunction. Diabetic patients being more prone for macro vascular disease and dyslipidemia, screening for thyroid disease among diabetic subjects could be of more value than screening of general population.
CHAPTER 5

SPECTRUM OF THYROID DYSFUNCTION AND ITS RELATION TO IODINE STATUS AND THYROID AUTOIMMUNITY IN FEMALES ABOVE 35 YEARS IN A CENTRAL KERALA COMMUNITY

BACKGROUND

Thyroid hormones are key regulators of metabolism as well as development and are known to have pleiotropic effects in many different organs. It has become clear that overt thyroid dysfunction is associated with significant morbidity and mortality. It is also shown that many of these disorders are sub clinical and hence undetected but may contribute to the morbidit y of the subjects. Thyroid disorders are more common in females than males all over the world. Females beyond the reproductive age are poorly studied though older females are known to have more thyroid problems.

OBJECTIVE

This study was done to assess the prevalence of various thyroid dysfunctions and its associated factors in middle age and above females from the population.

MATERIALS AND METHODS

This study was conducted as a cross sectional community survey of females above 35yrs living in a randomly selected urban area Elamakkara division of corporation of Cochin. The total number of inhabitants was 7001, (females 3578) living in 1612 households. One female of above 35 yrs (middle age or above) was randomly selected from the households situated in the study area, using WHO cluster sampling method. This study was approved by the institutional ethics committee.
Trained field workers visited the selected households and details of the socio-demographic status, dietary, lifestyle and medical history were collected using a validated questionnaire. Dietary consumption of known goitrogens such as cabbage, cauliflower, tapioca, as well as iodine rich foods such as fish, and seafood were quantified using a food frequency questionnaire and the consumption was assessed on a weekly basis.

During the checkup the subjects were physically examined and the medical history was verified. Anthropometric measurements and blood pressure were also measured. Goiter evaluation was done clinically by WHO method and was classified as none, Grade 1 or Grade 2. Serum Thyroid Stimulating Hormone (TSH), free Thyroxine (FT4) and Anti Thyroid Peroxidase Antibody (Anti TPO), FBS and total cholesterol were measured. Urine iodine was also determined at AIIMS IDD lab New Delhi. Ultrasound scan of the neck was done for all the participants in the field using a portable US scan machine and thyroid volume and texture were assessed by the scholar under the guidance of a radiologist.

Data was analyzed using SPSS version 11.0 using Chi square test, ANOVA, and Student’s t-test wherever applicable.

RESULTS

Among the 540 subjects surveyed 508 participated in the checkup. Subjects with complete data (471) were included for analysis. The mean age was 50.3 ± 10.7yrs and 53.2% were postmenopausal. Age distribution of study participants is shown in Fig. 1. Among these, 168 subjects (35.7%) had up to primary education, 231(49.0%) had studied up to secondary education whereas 72 subjects (15.3%) had higher education. Regarding economic status 121(25.7%) belonged to poor income category, 282 (59.9%) were middle income and 68 (14.4%) belonged to high-income group. Regarding dietary habits, 96% were non-vegetarians. Among these 84.9% of the subjects were using iodized salt. Previous history of thyroid problems was present in 7.2% of the study population.
Prevalence of various thyroid dysfunctions is shown in Fig. 2 and 3. Totally 32.3% of the subjects had thyroid dysfunction. Thyroid dysfunction was more common in younger subjects but this was not statistically significant (p=0.155).

TSH had negative correlation (r= -0.42, p=0.000) with freeT4 and positive correlation (r = 0.27, p=0.000) with anti TPO. But TSH had no significant correlation with age, thyroid volume and urine iodine.
Fig. 3 Distribution of total thyroid dysfunction and hypothyroidism in different age categories

Fig. 4 Prevalence of various factors associated with hypo and subclinical hypothyroidism compared to healthy subjects with normal thyroid function

Prevalence of various thyroid problems in different age groups is shown in (Fig.4) Subclinical hypothyroidism was the commonest abnormality (n=84) though only 10
subjects had TSH >10 uIU/ml. Out of these 41.4% of these patients were anti TPO positive whereas only 10.8% had goiter.

CONCLUSION

This study focused on females above 35 years and the results showed that thyroid dysfunction is very frequent in this iodine sufficient population and subclinical hypothyroidism being the commonest problem. Anti TPO antibody was present in about 40-60% of subjects with thyroid dysfunction suggesting autoimmune etiology.
CHAPTER 6

NORMAL DISTRIBUTION OF THYROID VOLUME AND ITS DETERMINANTS IN HEALTHY FEMALES ABOVE 35YEARS IN A CENTRAL KERALA POPULATION

BACKGROUND

Estimation of thyroid volume using ultrasound (US) scan is more precise than clinical examination. Hence most epidemiological studies utilize this method for the assessment of goiter prevalence and iodine status. The WHO has published normative reference range of thyroid volume for children of various groups of iodine deficient areas. As the volume of the thyroid gland depends on many factors, such as race, age, gender, body built, iodine status etc., the normal reference volume may be different for different population.

OBJECTIVES

The aim was to assess the normal distribution of thyroid volume in healthy females above 35yrs from a central Kerala community using ultrasound measurement and to identify the factors affecting thyroid volume.

MATERIALS AND METHODS

Sample selection and survey were done as described in Chapter 5. In addition to anthropometric measurement, physical examination, goiter grading and blood tests, ultrasound scan of the neck was done for all the participants in the field using a portable US scan. The volume of each lobe was calculated separately using WHO accepted formula \[\text{length} \times \text{width} \times \text{breath} \times 0.479\] and added together to get the total volume of thyroid. Subjects with low or high iodine status, family history of thyroid in addition to those with history or biochemical evidence of thyroid dysfunction or thyroid auto immunity were excluded. Subjects within 1year of delivery were also excluded. Those subjects with thyroid nodularity as per ultrasound were also
excluded to increase the precision of the results, Data was analyzed using SPSS version-11.0 using Pearson’s correlation coefficient, Chi square test, ANOVA and Student’s t-test wherever applicable.

RESULTS

Among the 540 subjects surveyed, 508 participated in the health checkup (non response, 8%). After applying exclusion criteria there were 109 healthy subjects out of 508 and only these subjects were included for further analysis. Mean age of these subjects was 52.8 ± 11.6 yrs and 59.3% were postmenopausal. Basic characteristics of these subjects are given in Table.1.

Table.1 Distribution of study variables among healthy study subjects (109)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean + SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>52.8 + 11.6</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>150.5 + 6.3</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>55.6 + 10.7</td>
</tr>
<tr>
<td>BMI (Kg/m2)</td>
<td>24.5 + 4.2</td>
</tr>
<tr>
<td>BSA (m2)</td>
<td>1.52 + 0.16</td>
</tr>
<tr>
<td>UIE (mcg/L)</td>
<td>185 + 55.7</td>
</tr>
<tr>
<td>Ft4 (ng/dl)*</td>
<td>1.21 + 0.16</td>
</tr>
<tr>
<td>TSH (ulu/ml)*</td>
<td>2.31 + 0.88</td>
</tr>
<tr>
<td>AntiTPO (Iu/ml)*</td>
<td>9.1 + 7</td>
</tr>
</tbody>
</table>
Thyroid volume (TV) for each lobe and total volume was calculated by WHO formula. The mean thyroid volume of these subjects was $8.9 \pm 3.1$ ml. The volume of right lobe was found to be $(4.62 \pm 1.71)$ larger than the left lobe $(4.28 \pm 1.64)$ and this was statistically significant ($p < 0.005$). The distribution of thyroid volume among this population is shown in Fig.1. The 97th centile of thyroid volume was 15.3ml and volume higher than this can be considered as goiter for this population.

![Thyroid volume distribution](image)

Fig.1  The distribution of thyroid volume among normal study population (109)

Age showed significant negative correlation ($p<0.001$) with TV whereas weight, height, lean body mass, body surface area, triceps skin fold thickness and subscapularis skin fold thickness showed significant positive correlations with TV. BMI and waist circumference did not have any significant correlations.

But after correcting for age only triceps and subscapularis skin fold thickness were showing significant positive correlations ($p 0.017$ and $0.005$) with TV. Dietary goitrogens were not estimated in urine or serum in these subjects though consumption of cabbage, cauliflower, tapioca, as well as iodine rich food items like fish, and seafood were quantified. None of these showed any significant correlations with TV.
The table below shows the Pearson’s correlations of thyroid volume with age and anthropometric variables:

<table>
<thead>
<tr>
<th>Variables</th>
<th>r</th>
<th>p</th>
<th>r*</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.43</td>
<td>&lt;0.001</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Weight</td>
<td>0.22</td>
<td>0.021</td>
<td>0.13</td>
<td>0.162</td>
</tr>
<tr>
<td>Height</td>
<td>0.20</td>
<td>0.031</td>
<td>0.07</td>
<td>0.49</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>0.13</td>
<td>0.183</td>
<td>0.11</td>
<td>0.262</td>
</tr>
<tr>
<td>Body Surface Area</td>
<td>0.24</td>
<td>0.011</td>
<td>0.14</td>
<td>0.156</td>
</tr>
<tr>
<td>Waist circumference</td>
<td>0.16</td>
<td>0.091</td>
<td>0.18</td>
<td>0.060</td>
</tr>
<tr>
<td>Lean body mass</td>
<td>0.25</td>
<td>0.008</td>
<td>0.12</td>
<td>0.201</td>
</tr>
<tr>
<td>Triceps skin fold</td>
<td>0.28</td>
<td>0.003</td>
<td>0.23</td>
<td>0.017</td>
</tr>
<tr>
<td>Subscapularis skinfold</td>
<td>0.28</td>
<td>0.003</td>
<td>0.27</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Direct correlations r*-partial correlations after adjusting for age

Table 2 Pearson’s correlations of thyroid volume with age and anthropometric variables (109)

Iodine levels, TSH, FT4, Anti TPO levels also did not show any correlations with TV though all these were within normal limits for these subjects. Multivariate linear regression analysis showed that only age (p<0.001) and subscapularis skinfold thickness (p= 0.005) and menstrual status (p =0.005) were statistically correlated with TV, though only 29% of the variation of TV among these samples were explained by these factors.
CONCLUSION

The results of this study revealed the normal volume range of thyroid gland among the healthy females above middle age in this iodine sufficient population for the first time. Age showed strong negative correlation with thyroid volume but skin fold thickness expressed positive correlation. This study highlights the need to derive age specific normal standards of thyroid volume in each geographic area. It also points to the importance of the possible relation of thyroid volume with quantity of adipose tissue present in the body, that need to be considered while deciding normal thyroid volume for the definition of goiter.
CHAPTER 7
IODINE STATUS AND THYROID VOLUME IN FEMALES ABOVE 35YRS IN CENTRAL KERALA

BACKGROUND

Thyroid disorders are more commonly seen in females all over the world. The studies done in females in India were all conducted on females of reproductive age probably because of the important role iodine and thyroid status play in the intelligence and health of the offspring. Most of the prevalence studies had been concentrated on goiter and iodine status and were conducted among school children. There is no population data from India focusing on iodine levels and their correlations with thyroid volume and other factors in adult women.

OBJECTIVES

The aim of present study is to assess the iodine status and its relation to thyroid volume and other factors in this population of females above 35yrs of age.

MATERIALS AND METHODS

This study was conducted as a cross sectional community survey of females above 35yrs living in a randomly selected urban area Elamakkara division of corporation of Cochin. Details of sample selection are given in Chapter 5.

All surveyed subjects were directed to undergo 10 h of fasting before attending the health checkup conducted in their locality. During the checkup the subjects were physically examined and the medical history was verified. Anthropometric measurements and blood pressure were also measured. Goiter evaluation was done clinically by WHO method and was classified as none, Grade1
or Grade 2. Serum Thyroid Stimulating Hormone (TSH), free Thyroxine (FT4) and anti Thyroid Peroxidase Antibody (Anti TPO), FBS and total cholesterol were measured. Urine iodine was also determined. Ultrasound scan of the neck was done for all the participants at their locality using a portable US scan machine and thyroid volume and texture were assessed. Data was analyzed using SPSS version-11.0 using Chi square test, ANOVA, and Student’s t-test wherever applicable.

RESULTS

Among the 508 subjects who participated in the checkup, 471 subjects were included for analysis. Mean age was 50.3 ± 10.7yrs and 53.2% were postmenopausal. Among these 98% of the subjects were using iodized salt and median UIE was 162.6mcg/L. Distribution of urine iodine is shown in Fig.1. Iodine status of various age categories is shown in Fig. 2. UIE had negative correlation with age and systolic BP, but had no correlation with TV, Thyroid nodularity, FT4, TSH or Anti TPO levels. Iodine deficiency was more commonly seen in subjects with hypertension and also among postmenopausal females probably this may be due to the older age of this group.

![Urine Iodine Levels](image)

Fig. 1 Distribution of UIE among study subjects (471)
Fig. 2 Iodine status and age n =471 (p=0.019)

Fig. 3 Linear relation of thyroid volume with iodine levels
GOITER AND IODINE STATUS

Mean urine iodine was not different among goitrous subjects when compared to those without goiter. Grade 1 goiter had more iodine deficiency but less iodine excess compared to Grade 2 goiters. Nearly half of both Grade 1 & Grade 2 goiters were associated with normal iodine status even though goiter does not represent immediate impact of current iodine levels.

Table. 1 Comparison of mean UIE levels among categorical variables

<table>
<thead>
<tr>
<th>Categories</th>
<th>Mean UIE +SD</th>
<th>p–value</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of HTN Yes (101)</td>
<td>143.18 + 91.93</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>No (370)</td>
<td>183.77 + 100.53</td>
<td></td>
</tr>
<tr>
<td>HTN-ATP3 Yes (285)</td>
<td>160.96 + 96.12</td>
<td>p&lt;0.001</td>
</tr>
<tr>
<td>No (186)</td>
<td>196.68 + 102.36</td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus Yes (92)</td>
<td>165.07 + 107.99</td>
<td>p=0.49</td>
</tr>
<tr>
<td>No (376)</td>
<td>177.53 + 98.41</td>
<td></td>
</tr>
<tr>
<td>Menstrual status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre menopausal</td>
<td>189.30 + 103.18</td>
<td>p=0.003</td>
</tr>
<tr>
<td>Postmenopausal</td>
<td>162.05 + 95.49</td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION

These results showed that females above 35yrs were iodine sufficient though one third of subjects had UIE levels less than the recommended level. Iodine levels had significant negative correlation with age and systolic BP but had no correlation with TV, thyroid nodularity, and Ft4, TSH or Anti TPO levels. Iodine deficiency was more
in subjects with Grade 1 goiter. The relation of iodine levels and blood pressure merits further evaluation.
CHAPTER 8

GOITER AND SONOLOGICAL THYROID VOLUME IN FEMALES ABOVE 35YEARS IN CENTRAL KERALA

BACKGROUND

Goiter or thyromegaly is a common thyroid disorder seen among adults. Measuring thyroid volume by ultrasound is considered as the gold standard of diagnosing goiter. Though India has been classified as an iodine sufficient country by WHO previous studies of school children from south Indian state of Kerala had shown a goiter prevalence of 16.6%. But there are not many studies among adults in this population. The presence of goiter and the correlation of factors associated with it are poorly studied in adults especially in females above the middle age.

OBJECTIVES

To assess the prevalence of goiter and associated factors and also to find out the thyroid volume by ultrasound in females above 35 yrs from a central Kerala community.

MATERIALS AND METHODS

Sample selection and survey was done as explained in Chapter 5. All surveyed subjects were directed to undergo 10 h of fasting before attending the health checkup conducted in their locality. During the checkup the subjects were physically examined and the medical history was verified. Anthropometric measurements and blood pressure were also measured. Goiter evaluation was done clinically by WHO method and was classified as none, Grade 1 or Grade 2. Thyroid volume was calculated using ultrasound measurement. Thyroid volume was expressed as total volume as well as thyroid volume per Kg body weight (volume/weight ratio). Serum Thyroid Stimulating Hormone (TSH), free Thyroxine (FT4) and anti Thyroid Peroxidase Antibody (Anti TPO), FBS and total cholesterol were measured. Urine
iodine was also determined. The data was subjected to appropriate statistical analysis using SPSS software.

**RESULTS**

Among the 508 subjects who participated in the checkup, 471 subjects were included for analysis. Mean age was 50.3 ± 10.7yrs and 53.2% were postmenopausal. Among the population 15.7 % had clinical goiter (9.1 % Grade1 and 6.6% Grade 2). Thyroid texture by palpation was as follows: single nodule- 2.6%, multiple nodules- 4.5% and diffuse swelling - 7.5%. Goiter was significantly (p 0.009) more common among younger subjects than older females (Fig.1). Mean thyroid volume of goitrous subjects was (19.5 ± 9.6ml) significantly (p<0.001) higher than non-goitrous subjects (9.64 ± 3.8 ml).

Mean urine iodine was not different among goitrous subjects when compared to those without goiter. Grade 1 goiter had more iodine deficiency but Grade 2 goiters had more iodine excess (Fig. 2). Nearly half of both Grade 1 & Grade 2 goiters were associated with normal iodine status.

![Fig.1 Goiter in different age categories (p= 0.009)](image)
Fig. 2 Iodine status among goitrous subjects (74) (p = 0.61)

**FACTORS ASSOCIATED WITH GOITER**

Independent sample test was done to compare subjects with goiter and those without goiter. Subjects with goiter had significantly (p <0.001) higher frequency of past history of thyroid disorders and family history (p=0.014) compared to those without goiter. Urine iodine levels, FT4 and TSH were not different between these 2 groups but presence of overall thyroid dysfunction was more common among subjects with goiter. Anti TPO anti body levels were significantly (p=0.001) higher among subjects with goiter than non-goitrous subjects. Body weight, BMI, WC, BSA and LBM were all higher in subjects with goiter. Premenopausal status was also significantly (p=0.027) more common among subjects with goiter. Consumption of goitrogens, economic status and parity and duration after menopause were similar between these two groups. The prevalence of diabetes and hypertension was also not different between these two groups.
Multivariate analysis showed that subjects with past history of thyroid disorder (OR 20.8) family history of thyroid disease (OR 3.31), positive Anti TPO (OR 2.69), presence of sonological abnormalities of thyroid (OR 16.26) and increased thyroid volume (OR 9.06) are strongly associated with goiter. Subjects in the age group <40yrs (OR of 5.4) and 40-60yrs (OR 2.32) were more likely to have goiter than subjects >60yrs.

**ETIOLOGY OF GOITER**

Among the subjects with goiter 17.6% had iodine deficiency and 29.7% had positive anti TPO antibody where as 13.5% had both iodine deficiency and autoimmunity (Fig.3) But 39.1% of the goitrous subjects had no iodine deficiency or autoimmunity suggesting other possible goitrogenic factors.

![Fig. 3 Etiological factors of goiter (74)](image)

**DIAGNOSIS OF GOITER- CLINICAL VS. ULTRASOUND TV**

Clinically goiter is diagnosed by WHO method where as sonologically goiter is defined as thyroid gland with volume more than 97th centile of TV distribution for normal population. This has been found to be 15.2ml as per data from normal subjects in this population. Out of 74 subjects with clinical goiter 28 (37.3%) had TV
within the normal reference range whereas 36 (48%) had normal TV/wt ratio. Among these 28 subjects with normal TV and clinical goiter, 6 subjects had normal sonological appearance and 22 subjects had sonological abnormalities (8 uninodular disease, 7 multinodular disease and 7 had diffuse changes). Clinical findings were in agreement with ultrasound method in 88% of the cases.

**CONCLUSION**

Clinical goiter was present in 15.7% (Grade 1- 9.10 % and Grade 2- 6.6%). Goiter prevalence was decreasing with age and postmenopausal status whereas antibody positivity, past history and family history of thyroid disease were all positively associated with goiter in these iodine sufficient females. Nearly 40% of the goiter no obvious etiological factor was found suggesting the possible role of other unidentified goitrogens. Diagnosis of goiter by US volume was more specific and presence of nodularity increased the likely hood of diagnosing goiter clinically.
CHAPTER 9
ULTRASONOGRAPHIC EVALUATION OF THYROID NODULARITY IN AN ADULT FEMALE POPULATION IN CENTRAL KERALA

BACKGROUND

According to western studies palpable thyroid nodules occur in 1.5 - 6.4 % of the general population and the incidence of non-palpable nodules is at least ten fold greater when the population is screened by ultrasonography. Non-palpable nodules increase with age to involve approximately 50% of older adults especially women. In India most of the studies on sonology of thyroid were done among children who have lesser chance of having nodular gland.

OBJECTIVES

Aim of this study was to assess the prevalence of thyroid structural abnormalities and its associated factors in females 35yrs and above among a central Kerala community.

MATERIALS AND METHODS

Sample selection and survey were done as described in Chapter 5. In addition to anthropometric measurement, physical examination, goiter grading and blood tests, ultrasound scan of the neck was done for all the participants in the field using a portable US scan. Thyroid structure is classified as follows;

Normal echo texture – image uniformly brighter than strap muscles without any focal changes

Diffuse changes – hypoechogenecity of any grade (image darker than strap muscles)

Less than 1cm nodules – nodular changes but less than 1cm in diameter
Single nodule- one nodule more than 1cm diameter of any consistency
Multiple nodules – more than one nodule with more than 1cm diameter
Data was analyzed using SPSS version-11.0 using Pearson’s correlation coefficient, Chi square test, ANOVA and Student’s t-test wherever applicable.

RESULTS

SONOLOGICAL ABNORMALITIES

Among the 471 subjects, USG showed normal consistency of thyroid gland in 69.2%. Abnormal sonographic findings seen in 30% of the subjects were as follows, 18.7% nodular changes, 10% diffuse goiter, 5.7% subcentimetric nodules (Fig.1).

SONOLOGICAL ABNORMALITIES IN NORMAL POPULATION

To assess the prevalence of thyroidal abnormalities in normal subject, from the total population 240 normal subjects were selected after excluding subjects with goiter, abnormal thyroid function and positive antibodies. Analysis showed that 12.1% of normal females had nodular changes >10mm in the thyroid gland. Among these subjects 7.9% had single nodule, 4.2% had multiple nodules, 6.2% had <10mm nodule and 0.8% had diffuse changes.

SONOLOGICAL ABNORMALITIES IN GOITROUS SUBJECTS

Sonologically detected abnormalities were significantly higher (p<0.001) among subjects with goiter (81.4%) than subjects without goiter (19.4%) (Fig.1).

Similarly nodularity was significantly more common in subjects with past history of thyroid disorders and positive anti TPO antibodies. Overweight and obese subjects as well as older subjects had more nodularity compared to their counterparts but this was not statistically significant. Thyroid function and iodine status had no correlation with nodularity. Diabetes had no relation but hypertensive subjects had more nodularity and this was statistically significant.
Multivariate analysis of the categorical variables showed that only presence of goiter (OR 5.96 CI 3.48-10.23 p<0.001) and age >50 years (OR 1.78 CI 1.13-2.80 p=0.014) were positively associated with nodularity.

CONCLUSION

Abnormal sonographic findings were seen in 30% of these iodine sufficient female population and were as follows: nodular changes in 18.7%, diffuse changes in 10% and subcentimetric nodules in 5.7%. Even in healthy subjects without goiter, 20% had incidentally discovered sonological abnormality of the thyroid. Thyroid structural abnormalities were more common among subjects more than 50yrs and those with goiter.
CHAPTER 10

THYROID AUTOIMMUNITY AND ITS CONTRIBUTION TO
THYROID DISORDERS IN FEMALES ABOVE 35 YEARS IN
CENTRAL KERALA

BACKGROUND

Autoimmune thyroid disorders are the commonest form of organ specific autoimmunity disorder. Autoimmunity can cause destruction of the gland leading to hypothyroidism, whereas some antibodies can lead to hyperthyroidism. Autoimmunity of the thyroid can be detected by the presence of autoantibodies to thyroid antigens such as anti TPO and anti TG antibodies in the serum. Many factors such as genetic factors, environmental pollutants, and iodine status can predispose or trigger autoimmune activation. Hence prevalence of thyroid autoimmunity can vary from place to place.

OBJECTIVES

The aim of this study was to assess the prevalence of thyroid autoimmunity in female above 35 yrs and to evaluate its relationship with iodine status, thyroid dysfunction and goiter.

MATERIALS AND METHODS

Sample selection and survey was done as explained in Chapter 5. All surveyed subjects were directed to undergo 10 h of fasting before attending the health checkup conducted in their locality. During the checkup the subjects were physically examined and the medical history was verified. Anthropometric measurements and blood pressure were also measured. Goiter evaluation was done clinically by WHO method and was classified as none, Grade1 or Grade 2. Thyroid volume and structural changes were assessed using a portable ultrasound machine. Serum Thyroid
Stimulating Hormone (TSH), free Thyroxine (FT4) and anti Thyroid Peroxidase Antibody (Anti TPO), FBS and total cholesterol were measured. Urine iodine was also determined. The data was subjected to appropriate statistical analysis using SPSS software.

RESULTS

Among the 508 subjects who participated in the checkup, 471 subjects were included for analysis. Among the subjects 24% (114) had positive anti TPO levels. Anti TPO levels expressed a significant negative correlation with FT4 (r = -0.208 p =0.000) and age (r 0.79 p =0.09), where as TSH (r 0.27 p =0.000) and thyroid volume (r 0.253 p=0.000) had a positive correlation. No correlation with urine iodine (r 0.06 p =0.22) or with family history of thyroid disorder could be detected. Goiter, thyroid nodularity and thyroid dysfunction were significantly higher in subjects with positive Anti TPO antibodies. (Table.1)

Table.1 Prevalence of various thyroid related factors in subjects with and without thyroid autoimmunity.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Subjects with positive anti TPO (114)</th>
<th>Subjects with negative anti TPO (371)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goiter %</td>
<td>42.2</td>
<td>20.2</td>
<td>0.003</td>
</tr>
<tr>
<td>Thyroid dysfunction %</td>
<td>44.8</td>
<td>14.1</td>
<td>0.000</td>
</tr>
<tr>
<td>Iodine deficiency %</td>
<td>32.1</td>
<td>28.5</td>
<td>0.268 NS</td>
</tr>
<tr>
<td>Nodular changes%</td>
<td>42</td>
<td>27.5</td>
<td>0.003</td>
</tr>
</tbody>
</table>

CONCLUSION

This cross sectional community survey of these iodine sufficient south Indian females above 35years in central Kerala had shown high prevalence (almost one in 4 subjects)
thyroid autoimmunity as evidenced by positive anti TPO antibody which had significant correlations with TSH and thyroid volume. Iodine levels and age had no correlations. According to this study only 40% of the goiters and thyroid dysfunction had autoimmune etiology.
CHAPTER 11

CONCLUSION

This study concluded that thyroid disorders, diabetes mellitus and obesity are common problems in our community and majority of these problem remain undetected. Both diabetic and nondiabetic subjects had similar prevalence of thyroid problems in this study. This study population is iodine sufficient and current iodine levels appear to have no significant association with goiter, thyroid structural abnormalities, thyroid autoimmunity or thyroid dysfunction. Goiter prevalence is higher than that is recommended for iodine sufficient population. Subclinical hypothyroidism is the commonest thyroid disorder seen in this population especially among older females. This picture may be the effect of transition from iodine deficiency to sufficiency though similar data among the adults in the pre iodization phase is not available for comparison. Thyroid auto immunity is present in only 40-50% of subjects with goiters and thyroid dysfunction. But for almost 60% of the thyroid problems no apparent etiological factors are present pointing to the possible role of other etiological factors such as environmental chemicals and pollutants. Ultrasound evaluation of thyroid gland in adult female population showed that normal thyroid volume is 8.9 + 3.1 ml and thyroid volume showed negative correlation with age and positive correlation with body stature. Sonological abnormalities were present in 30% of these subjects.

These study findings provided insight into the prevalence of thyroid disorders and diabetes in an adult population in India. It also points to the need of screening high-risk group for undetected thyroid problems. But being a regional study it has the inherent limitation of not representing the entire Indian population. However these observations highlight the need of nationwide surveys to recognize the magnitude of these two common endocrine problems in our country and also to look at the possible etiological factors for the increasing prevalence.
Papers Published from this study


